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The Composition of the Chemicals, Antioxidants, and Anti-Microbial Agents on the Essential Oil of the Piper Species and Its Potential as A Natural Preservative: A Review

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ABSTRACT

The production of safe food with a little to no artificial preservatives is the main and most important challenge for the food manufacturing industry. Increasing demand of using the safe preservatives has pushed the food industry to use the herbal or natural preservatives. The essential oil of the piper species consists of complex compounds like the monoterpene that has a power in the activity of the antioxidant and antibacterial. The object of research is the essential oil of piper species like the Piper nigrum, Piper betle, Piper retrofractum, Piper caninum, and Piper cubeba. The review methodology used in this research is the PRISMA flowchart (2020). PRISMA aims to identify the quality of papers and transparency of the number of articles. The objective of this research is to summarize the research related to the chemical content of the piper essential oil, the antioxidant and anti-microbe as the potential natural preservatives. The anti-microbe activity on the piper species shows the MIC score ranging from 1.5 to 12.8 μg/mL towards the standard of bacterial preservatives in preventing pathogens in foods. The essential oil of piper species has the higher antioxidant compared to the synthetic ones, like the BHA and BHT that have the score of IC_{50} <50 μg/mL. The essential oil of piper species has the GRAS certification and "safe" as an additive in foods.

1. INTRODUCTION

Synthetic anti-microbe and additive chemical substances may affect negatively on the people's health. Food's safety has become the main priority of the consumers and the food industry. The rise of various resistant microorganisms due to the use of synthetic preservatives caused a huge demand for the development of natural preservatives (Basak & Guha, 2017). A safe foods production that does not involve any artificial preservatives is a main and most important challenge for the food manufacturing industry (Sharifi-Rad *et al*., 2018). Synthetic preservatives is still limited in term of use and is now being evaluated towards its negative impact on the health and environment (Pawar *et al*., 2011). The addictive chemical substances that are added in the foods have a negative impact on the consumers. Todays consumers begins to refuse products that contains addictive substance or artificial additive (Cacho *et al*., 2016). The food industry is now searching for the new and safer substance to fulfill the challenge on natural preservatives so that the chemicals are not used anymore (Prakash *et al*., 2018). The plant species in the world are about 500,000 of species and are predicted that only about 1 to 10% (around 50 to 500 species) are used as a food preservative (Nereyda & Sauceda, 2011). The use of the essential oil as the natural food supplement has become the focus because of the presence of active agent. That makes the essential oil becomes successful to replace the chemical food additives (Morais-Braga *et al*., 2022). The essential oils are spices that is made from plants and certified to be “safe” by the GRAS and US FDA (Generally Recognized Safe). GRAS is the certification on chemicals that is added into foods that has the status of “safe” (Ribeiro-Santos *et al*., 2017).

Essential oil from the *Pipericeae*, which is an aromatic plant, contains anti-microbe and antioxidant that has the potential to be a natural preservative. The piper species are often used in the industry of pharmacy, perfumery, cosmetics and foods (Sharifi-Rad *et al*., 2018). The piper species contains essential oil in its tissues, like in the seeds, fruits, leaves, roots, branches, and trunks (da Silva *et al*., 2017). Piper nigrum is a spice that is commonly found and is called as the “King of Spices” (Chen *et al*., 2012). The consumption of Piper nigrum on 2020 is estimated to reach 280.000 ton worldwide The consumption of Piper nigrum on 2020 is estimated to reach 280,000 ton worldwide (Hao *et al*., 2012). Beside the Piper nigrum, the other species like Piper betle, Piper retrofractum, Piper cubeba and Piper caninum that also have an important role to the economic sector (Nur Sazwi *et al*., 2013). Those piper species have various benefits compared to the other species of piper (Salehi *et al*., 2019). The essential oil from the piper species consists of a complex compounds that contain monoterpene hydrocarbons, susquiterpene hydrocarbons, oxygenated monoterpene, and oxygenated sequiterpene (Keerthana & Narayanan, 2021). The essential oil of the piper species has a very promising antioxidant and anti-microbe that act as a food preservative to control various food decayers and pathogenic microorganism (Nikolić *et al*., 2015). Recently, there has not much research on the essential oil from the piper species as a potential natural preservative so that it needs further research. This review discusses about the chemical compounds on the essential oil of the piper species and its potential as the natural food preservative.

2. METHODS

To gain a database about the essential oil of the piper species that has a potential as a preservative, then the search on the literature on the publishers like Science Direct, Springer, MDPI and the Publish or Perish (POP) application is performed. The search resulted to 716 articles found from 2011-2022, as shown in Figure 1. Then, the found articles are selected based on the title and the abstract so that there are 62 articles journal in that are a full text and are open access. The total article that fulfill the criteria and are included in the review are 26 titles. The database that contains antioxidant are 22 journals, and the database that contain antioxidant and anti-microbe are 13 articles.

3. RESULTS AND DISCUSSION

3.1. Composition of Piper Species Essential Oil

Essential oil has 20 to 60 natural compounds in different amount (Prakash *et al*., 2018). The essential oil is from plants that have a complex component or compound from the nature, the polar as well as the non polar compound (Karak *et al*., 2018). The main class compounds of the essential oil of piper species are the monoterpene hydrocarbons,

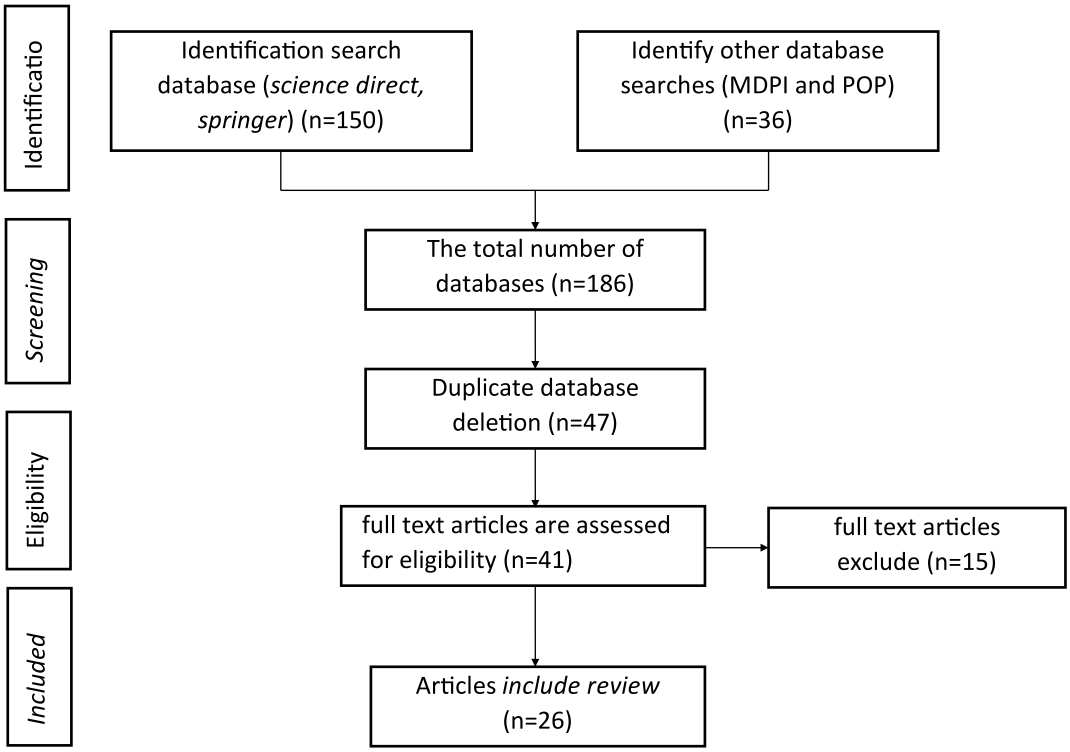

Figure 1: The flow chart of the search strategy consists of the identification of potential relevant material, preliminary screening and final selection included in this review (based on PRISMA 2020 guidelines). The full-text exclude article is a lack of data information related to antioxidants or antimicrobials that have the potential to be natural preservatives.

oxygenated monoterpenoid, susquiterpene hydrocarbons, sesquiterpenoid and other compounds (Liu *et al*., 2018), the dominant compounds of the piper species essential oil are shown in Table 1. The piper species essential oil, from the terpene group (monoterpene and sequinterpene) are the main component with 20 to 70%, compared to the aromatic compound (alcohol, aldehyde, phenol, and so on) and terpenoid (Tongnuanchan & Benjakul, 2014). The most dominant compound on the piper species essential oil on the monoterpene group are limonene, sabinene and a-thujene; on the oxygenated monoterpene group is the linalool, on the sequiterpene hydrocarbon group is the caryophyllene, on the oxygenated sequiterpene group is the caryophyllene oxidate and on the phenylpropanoid is the eugenol (Madhumita *et al*., 2019). The component compound on the essential oil can determine the biological characteristics of it. The compound and the the aroma of the essential oil are divided into two group, the hydrocarbon terpene and the oxygenated compounds (Raut & Karuppayil, 2014).

3.1.1. Hydrocarbon Terpene

Hydrocarbon is the molecule that has the atom H and atom. Terpene is the most common class of chemical compound found in essential oils. Terpene that comes from the isoprene with carbon base (C_5) is the combination of 2 isoprene units called "terpene" (Bhanja *et al*., 2022). The dominant essential oil consists of the monoterpene (C_{10}) and the sequiterpene (C_{15}) that has the common formula of $(C_5\ H_8)_n$ terpenoid (a terpene that contains oxygen)(Takahashi *et al*., 2020). Most of the essential oils contain monoterpene of $C_{10}H_{16}$ and the sequiterpene of $C_{15}H_{24,}$ the sequiterpene component has the bigger molecule or structure, but the functional characteristics of the sequiterpene is the same with the monoterpene (Tongnuanchan & Benjakul, 2014).

Table 1: The major components of the essential oil of the piper species

Essential oil	Source	Monoterpene Hydrocarbons	Oxygenated Monoterpenes	Sesquiterpene Hydrocarbons	Oxygenated Sesquiterpenes	Other	Reference
Piper nigrum	Indonesia	β-thujene (20.58%)	terpinen-4-ol (1.85%)	β-caryophyllene (51.12%); β-Selinene (5.59%); δ-elemene (5.03%); humelene (3.8%); cadinene (2.04%)	Caryophyllene oxidate (1.51%); cubenol (0.97%)		(Andriana *et al.*, 2019)
Piper nigrum	China	Limonene (8.77%); t-carene (11.06%)		(E)-caryophyllene (54.59%); humelene (3.43%)	Caryophyllene oxidate (3.61%)	Methyl ester (3.48%)	(Li *et al.*, 2020)
Piper nigrum	Malaysia	3-carene (6.26%); β-thujene (1.38 %); sabinene (13.19%); α- & β-pinene (7.96 & 9.71%); camphene (0.28%); α-phellandrene (1.60%); terpinolene (0.16%); myrcene (1.15%); limonene (14.95%); β-ocimene (0.46%); γ-terpinene (0.26%); ρ-cymene (1.15%); 3-carene (8.56%)	Trans-sabinene hydrate (0.16%); cis -sabinene hydrate (0.28%); linalool (0.61%); terpinen-4-ol (0.59%); α-terpineol (0.68%)	Caryophyllene (25,58-52,23%); δ-elemene (2.0%); cadinene (0.23%); copaene (3.73%); α- & β-bisabolene salinene (0.82% & 1.77%)	Caryophyllene oxidate (1.22%)	Trans-nerolidol (0.10%); cubenol (0.11%)	(Bagheri *et al.*, 2014)
Piper nigrum	India	sabinene (12.6%); Limonene (11.9%); α- & β-pinene (2.5% & 7.3%); α-thujene (0.8%); myrcene (0.9%); α- & β-phellandrene (0.4% & 2.2%); 3-carene (0.3%); α-terpinene (0.2%); ρ-cymene (0.2%); γ-terpinene (0.4%)	Linalool (1.5%); cis-sabinene hydrate (0.6%); Trans-sabinene hydrate (0.3%); terpinen-4-ol (3.9%); α-terpineol (0.8%)	Caryophyllene (16%); β-elemene (1.0%); α -humelene (0.9%)	Caryophyllene oxide (1.6%); epicubebol (1.2%); cubebol (4.4%)	Torreyol (9.3%)	(Singh *et al.*, 2013)
Piper caninum	Malaysia	α- & β-pinene (4.0% & 8.9%); champhehe (0.28%); myrcene (0.9%); limonene (3.9%); β-ocimene (3.4%)	Linaloll (7.0%); Terpinene (0.1%); α-terpineol (0.4%); terpinen-4-ol (0.2%)	β-caryophyllene (6.7%); β- & δ-elemene (2.1% & 1.8%); α-copaene (0.5%); α-humelene (1%); zingiberene (0.4%)	Caryophyllene oxide (0.2%)	Eudesmol (0.9%); Safrole (17%)	(Salleh *et al.*, 2011)
Piper cubeba	Saudi Arabia	β-myrcene (1.23%); limonene (0.12%); β-ocimene (0.30%)	Linaloll (0.22%); 1,8 ciniole (2.94%); α-Terpinolene (1.41%); terpinen-4-ol (1.8%); ρ-cymene-8-ol (3.50%); α-terpineol (0.96%); citronellol (0.10%); geraniol (0.19%)	β-elemene (0.66%); Caryophyllene (5.65%); α-humelene (1.14%); α-salinene (0.47%)	Caryophyllene oxide (0.96%); viridiforol (0.39%)	Eugenol (33.95%); Methyl-eugenol (41.31%)	(Alminderej *et al.*, 2020)

3.1.2. Oxygenated Compound

Oxygenated compound is the compound that has the combination of the elements of C, H, and O as well as the compounds found in the essential oils(Fan *et al*., 2020). The oxygenated compound are derived from the terpene called “terpenoid”. The oxygenated compound in the essential oil like phenol (eugenol, carvacrol, timol), aldehyde (citral, myrtenal, cuminaldehyde, citronellal) and others (Tongnuanchan & Benjakul, 2014).

3.2. Piper Species Essential Oil as the Natural Preservative

The essential oil has the function that can be used as the natural additive or preservative. The function of natural preservative can be divided into two, as anti-microbe (preserving or inhibiting the microbe like fungus and bacteria), and also as antioxidant (stopping or delaying the oxidation) (Pawar *et al*., 2011). Anti-microbe and antioxidant are really important properties in the food preservation (Singh *et al*., 2019). The anti-microbe agents have become constant needs and interest in the development of new technology, so that it can be used in increasing the safety and the quality of food (Gyawali & Ibrahim, 2014). The essential oil from the piper species has a promising amount of antioxidant and anti-microbe to be used as the food preservative because the anti-microbe in the piper species can be used to control various food expiration and any pathogenic microorganism (Nikolić *et al*., 2015).

3.2.1. Anti-Microbial Activity

A safe food that contains no chemical additives has become the constant demand of the consumers, that cause the tendency to search for food additives that are made of the natural sources (Cacho *et al*., 2016). The producers, recently, needs a new way to reduce or eliminate the pathogen within the food so that it can result to a safe food with small impact to the environment (Ribeiro-Santos *et al*., 2017). Therefore, the use of essential oil as the antibacterial additive has become a popular choice of the people in the food industry (Ahmad *et al*., 2010). The essential oil is the mixture of complex compounds that is effective in handling the food pathogens like the fungus and bacteria (Nikolić *et al*., 2015). The piper species essential oil is recommended to be a food additive that is safe for the consumer and the environment because of its strong ability to slow bacterial resistance (Singh *et al*., 2013). The essential oil of the piper species has a function on dealing with the food pathogen and it is able to be used as food preservative since the oil from the piper species has the anti-microbial characteristics (Rukayadi *et al*., 2013). Essential oil that has anti-microbial characteristics can be added to food (Nikolić *et al*., 2015). The standard for a food preservative is the ability to prevent the growth of bacteria and fungus like the *Aspergilus niger* (Fungus), *Candida albicans* (Fungus), *Escherichia coli*, *Pseudomonas aeruginosa* (gram-positive bacteria) and *Staphylococcus aureus* (gram-negative bacteria) (Rukayadi *et al*., 2013).

The most active compounds on the essential oil and has important role on the antibacterial activity are the chemicals like terpenoid (carvaro, tymol), terpene (limonene. P-cymene, Caryophyllene), Phenylpropanoid (eugenol) (Hyldgaard *et al*., 2012). The essential oil of *Piper nigrum* has monoterpene like the 2-cerene and thujene, such components have the anti-fungal activity (Kang *et al*., 2019). The monoterpene like the D-Limonene has the role in killing the gram-negative bacteria and the caryophyllene has the role in killing or slowing the gram-positive bacteria (Makpol *et al*., 2013). The monoterpene compound becomes the main active agent on the *Piper nigrum* essential oil (Bagheri *et al*., 2014; Li *et al*., 2020). The compound has a role as the anti-microbial activity by destroying the bacterial membrane and limiting the growth of the bacteria (Alminderej *et al*., 2020).

The anti-microbial activity on the essential oil of piper species is evaluated using the gram-positive bacteria (*Bacillus subtilus*, *Staphylococcus aureus*, *Bacillus cereus*), gram-negative bacteria (*Pseudomonas aeruginosa*, *Escherichia coli*), and the anti-fungal (*Candida albicans*, *Aspergillus niger*) to find out the Minimum Inhibition Concentration (MIC) score (Annegowda *et al*., 2013). The MIC is the lowest concentration of the anti-microbial activity (Nikolić *et al*., 2015). Parameters of antimicrobial activity that have been established based on the MIC is shown in Table 2 (Freires *et al*., 2015). The score of the MIC can be observed on the Table 3. The MBC/MFC (Minimum Bacterial Concentration / Minimum Fungi Concentration) is the lowest concentration, which shows that 100% microorganisms are killed (Rukayadi *et al*., 2013).

Table 2: Parameter determined of the MIC of the Essential Oil

MIC range	**Antibacterial activity**
<100 □g/mL	Very Strong activity
101-500 □g/mL	Strong activity
501-1000 □g/mL	Intermediate activity
1001-2000 □g/mL	Weak activity
>2001 □g/mL	No activity

The piper species oil like the *Piper nigrum* has the MIC score of 1.5 to 12.8 µg/mL, the most vulnerable bacteria stain is the *S. aureus*, *Candida albicans*, and the *Escherichia coli* (Rukayadi *et al*., 2013). The MIC score of the *Piper betle* oil is 0.625 to 5 µg/mL on *B. subtilus*, *P. aeruginosa,* and *E. coli* bacteria. The MIC score of the piper species oil shown is <100 □g/mL, which proves that the essential oil of the piper species has a strong anti-microbial activity (Salleh *et al*., 2011). Piper species has good antimicrobial activity as evidenced by its low MIC value so that essential oils of piper species can be used to inhibit bacteria in food (Sarma *et al*., 2018).

3.2.2 Antioxidant Activities

In foods, there are oil and fat that is easy to be broken due to the oxidation or the formation of free radicals (Das *et al*., 2022). Oxidized compounds cause the changes on food that makes it less tasty and the characteristics are also changed and being less desirable (Sharifi-Rad *et al*., 2018). The antioxidant can help in preventing the oxidation process or the prevent the free radicals. Free radicals or oxidized stress is very dangerous for the human body because it can cause any degenerative issues like heart attack and cancer. Thus, human needs to consume foods with antioxidant compounds (Singh *et al*., 2013). Antioxidants are very important for the health. When the antioxidants are added on the food, it can increase shelf life due to the inhibition of lipid oxidation (Zarai *et al*., 2013).

Based on the source, antioxidants are divided into two categories, synthetic antioxidants and the natural antioxidants. Synthetic antioxidants like the butyl hydroxyl anisole (BHA) and the butyl hydroxyl toluene (BHT) that have the function to protect from oxidative damage (Nikolić *et al*., 2015; Yu *et al*., 2020). Synthetic antioxidants are usually used on the food industry to prevent lipid oxidation on food (Nikolić *et al*., 2015). The antioxidants, synthetic and natural ones, have become the group of food additives that is needed especially because of their ability to increase

Table 3: Anti-imicrobial activity of piper oil as a potential natural preservative presented as MIC and MBC

Piper Species	Source	*A.n*		*C.a*		*E.c*		*P.a*		*S.a*		*B.s*		*B.c*		References
		MIC	**MFC**	**MIC**	**MFC**	**MIC**	**MBC**	**MIC**	**MBC**	**MIC**	**MBC**	**MIC**	**MBC**	**MIC**	**MBC**	
Piper nigrum	Indonesia	12.8	25.6	3.2	6.4	3.2	6.4	12.8	25.6	1.5	3.2	-	-	-	-	(Rukayadi *et al*., 2013)
Piper betle	Malaysia	-	-	-	-	0.625	17.0	0.625	15.0	1.25	15.0	0.625	15.0	-	-	(Annegowda *et al*., 2013)
Piper caninum	Tunisia	>500	-	>500	-	62.5	62.5	250	250	250	250	250	250	-	-	(Salleh *et al*., 2011)
Piper nigrum	Malaysia	5.00	10.0	-	-	2.50	10.0	0.07	0.31	0.31	0.60	-	-	0.31	0.60	(Nikolić *et al*., 2015)
Piper betle	Germany	-	-	10.2	12.97	8.23	13.23	-	-	10.7	14.67	-	-	10.77	11.63	(S. Singh *et al*., 2013)
Piper nigrum	China	-	-	4.0	8.0	-	-	-	-	-	-	-	-	-	-	(Li *et al*., 2020)
Piper retrofractum	Indonesia	-	-	-	-	25.6	>51.2	12.8	>51.2	25.6	>51.2	-	-	-	-	(Wasito *et al*., 2011)
Piper nigrum	Malaysia	12.5	12.5	25.0	25.0	12.5	12.5	25.0	50.0	12.5	25.0	-	-	-	-	(Akthar *et al*., 2014)
Piper cubeba	Indonesia	12.8	25.6	1.6	3.2	3.2	6.4	6.4	12.8	1.6	3.2	-	-	-	-	(Rukayadi *et al*., 2013)
Piper nigrum	Pakistan	-	-	-	-	8.0	9.0	11.0	10.0	8.0	9.0	10.0	9.0	-	-	(Irshad *et al*., 2017)
Piper betle	Philippine	19.0	19.0	-	-	312	312	156	312	-	-	-	-	-	-	(Valle *et al*., 2016)
Piper nigrum	India	25.7	47.3			9.3	11.9	10.1	12.7	17.5	19.1	11.1	14.5			(S. Singh *et al*., 2013)
Piper betle	India	1.2	1.7			1.4	2.5			3.5	3.0	1.5	2.7			(Sarma *et al*., 2018)

Note: A.n =*Aspergillus niger*; C.a= *Candida albicans*; E.c= *Escherichia coli*; P.a= *Pseudomonas aeruginosa;* S.a= *Staphylococcus aureus*; B.a= *Bacillus subtilis*; B.c= *Bacillus cereus*; MIC=Minimum Inhibition Concentration (μg/mL; MBC =).

the shelf life of food without damaging the sensory qualities and the nutrition (Saini *et al*., 2021). The synthetic preservatives are used since the price is cheap and the good antiseptic effects, but it may also be harmful for the health and the environment (Zhang *et al*., 2021). The natural antioxidants can replace the synthetic antioxidants (Nikolić *et al*., 2015). Essential have complex compounds, and are source of the natural antioxidants (Salleh *et al*., 2011).

The essential oils from the piper species has the promising properties to be a food preservative (Nikolić *et al*., 2015). The essential oil from the piper species shows the strong properties on the antioxidants activity because of the terpene compounds (monoterpene and sequiterpene) and the phenolic that is significantly improving the capture of free radicals. This makes the essential oil of the piper species can be used to replace the synthetic antioxidants (Alminderej *et al*., 2020; Li *et al*., 2020).

The compound of caryophyllene, limonene, -pinene, 3-carene and the sabinene also contribute on the antioxidants activity (Bagheri *et al*., 2014). Piper species such as *Piper nigrum* can inhibit the lipid oxidation process at a concentration of 1-2 mg/mL. Oxidation inhibition process reached 73,6% and compared with synthetic antioxidant BHT 83.05%. This shows that *Piper nigrum* is more effective that BHT dan VC (Zhang *et al*., 2021).

The antioxidant activity is presented with the score of IC_{50} (inhibitory concentration). IC_{50} is the amount of the concentration that can inhibit the free radicals activity of 50% (Hutami *et al*., 2021). The antioxidant activity is classified as very strong if the IC_{50} score is less than 50 ppm and it is classified as weak if the score is more than 200 ppm. The antioxidants activity on the essential oil of the piper species is presented in the Table 4. The comparison result on table 4 shows the strong IC_{50} antioxidant score in preventing the lipid oxidation. Table 4 shows a comparison of the value of antioxidant activity and synthetic antioxidants. *Piper nigrum* has 65.59% antioxidant activity and 60% BHT synthetic antioxidant (Zarai *et al*., 2013). *Piper betle* with a concentration of 20 ug/ml has 45% antioxidant activity and 47% BHT (Annegowda *et al*., 2013). *Piper betle* compared to ascorbic acid which has antioxidant activity value of 74.20% and 72.68% (Singh *et al*., 2019). *Piper cubeba* has an antioxidant value of 110 ug/ml and ascorbic acid 114 ug/ml. *Piper caninum* has 103.5% antioxidant activity and 95% BHT (Alminderej *et al*., 2020). The Antioxidant activity of the piper species are also compared to the synthetic antioxidant like BHA and BHT, the comparison result shows that the antioxidant from the essential oil of the piper is not that significantly different from ones of the BHA and BHT. The result from table 4 shows the conclusion that the essential oil of the piper species can be used as the natural antioxidants on foods, and the antioxidant on the piper species oil has the potentials to be used as the natural preservative. This is done to prevent the lipid oxidation on the foods.

3.5. Future works

Piper species oil has the opportunity to be developed as a natural preservative in industry because after being studied piper species oil has strong antimicrobial properties besides that it also has antioxidant activity. Antioxidant activity in piper species is better than synthetic antioxidants BHA, BHT and Ascorbic acid in preventing oxidation processes in food. Piper species have a high opportunity to be applied in various food industries. The greatest application of the use of piper species in the food industry as an enhancer of taste, aroma and preservative.

The challenge faced when essential oils of piper species are used as preservatives is that it takes the right concentration so as not to change the organoleptics in foods such as taste, aroma and texture, in addition to the challenge for the industry is usually synthetic preservatives are cheaper than natural preservatives. In addition, further studies are needed regarding the influence of characteristics when applied to food such as changes in taste, aroma and texture. It also needs to be studied regarding the period of storage of food after being given piper oil and needs to be further researched

Table 4. Antioxidant activity of piper oil as a potential natural preservative

Piper Species	Source	Activity Antioxidant: Antioxidant Test	Activity Antioxidant: Antioxidant Activity Value	Synthetic Antioxidant Comparison	Result	References
Piper nigrum	Germany	DPPH	IC_{50}= 36.84±2.04 mg/ml	BHA= 0.42±0.01 mg/ml	Value of antioxidant activity in chicken sub that has been mixed with EO 0.156-0.689 mg/ml	(Nikolić *et al.*, 2015)
Piper cubeba	Indonesia	DPPH ABTS	IC_{50}= 0.82±0.06 mg/ml IC_{50}= 1.32±0.04 mg/ml	BHT=0.009±0.02 mg/ml	*Piper cubeba* holds promise as a food oxidative source	(Andriana *et al.*, 2019)
Piper nigrum	Indonesia	DPPH ABTS	IC_{50}=1.15±0.08 mg/ml IC_{50}=1.74±0.03 mg/ml	BHT=0.07±0.01 mg/ml	*Piper nigrum* is a promising source for reducing oxidative stress	(Andriana *et al.*, 2019)
Piper nigrum	Tunisia	DPPH Reducing power	Value DPPH= 65.59% Value : 25-75?g/ml	BHT= 50 ?g/ml (60%)	Phenolic compounds can prevent lipid degradation	(Zarai *et al.*, 2013)
Piper betle	India	DPPH	Value DPPH= 74.20±0.92% (consentration 500 ?g/ml)	Askorbat acid = 72.68±0.67%	The DPPH test was found to be equivalent to ascorbic acid for food safety. Extraction using methanol	(T. P. Singh *et al.*, 2019)
Piper caninum	Malaysia	DPPH $_{β}$-caroten/ linoleic acid	IC_{50}=187.6±0.45 mg/ml IC_{50}=103.5±0.35%	BHT=43.5±0.25 BHT=95.5±0.30%	Redox properties and chemical structure that can play a role in inhibiting lipoxygenase and free radicals	(Salleh *et al.*, 2011)
Piper cubeba	Saudi Arabia	DPPH FRAP $_{β}$-caroten	IC_{50}=110.00±0.08 ?g/ml IC_{50}=106.00±0.11 ?g/ml IC_{50}=315.00±2.08 ?g/ml	- Askorbat acid =114.00±0.70 ?g/ml - Askorbat acid =330.00±0.60 ?g/ml -BHT= 930±0.02 ?g/ml	*Piper cubeba* has strong antioxidants and can be developed as a high potency antioxidant agent	(Alminderej *et al.*, 2020)
Piper betle	Malaysia	DPPH ABTS	Inhidition= 45% (consentration 20 ?g/ml) Value ABTS= 57% (consentration 10 ?g/ml)	BHT=47% BHT = 55%	Antioxidant activity value in *Piper betle* Equivalent to synthetic antioxidants using soxlet and maceration methods	(Annegowda *et al.*, 2013)
Piper betle	Usa	Hydrogen peroxide ABTS	Value IC_{50}= 37.48±2.85 ?g/ml Value IC_{50}= 57.74±2.05 ?g/ml	Askorbat acid= 19.45±3.66 ?g/ml Ascorbat acid= 49.51±21.2 ?g/ml	Equivalent to ascorbic acid positive control, *Piper betle* can be used in the food industry to prevent oxidation and rancidity	(Saini *et al.*, 2021)
Piper cubeba	Saudi Arabia	DPPH	Value IC_{50}= 78.9 g/ml	Askorbat acid =19.2 g/ml	Concentration of 500 g/ml antioxidant activity 89.9% and almost equivalent to 92% ascorbate	(Mothana *et al.*, 2017)
Piper nigrum	China	DPPH ABTS	Value DPPH=73.6% (consentration 1-2 mg/ml) Value ABTS= 1.4250 ppm (consentration 1 mg/ml)	BHT= 83.05% VC=15.18 % BHT= 1.1617 ppm VC= 1.5734 ppm	Hydrodistillation showed strong activity against lipid peroxide which was more effective than VC only slightly less effective than BHT	(Zhang *et al.*, 2021)

DPPH(2,2-Diphenyl-1-picrylhydrazyl); ABTS (2,2-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid));FRAP (6-sulfonic acid)); FRAP (The Ferric Reducing AntioxidantPower) regarding the concentration of piper oil that does not change the organoleptics of food so that it is accepted by consumers, as well as the safety and side effects that must be carried out in further research.

4. CONCLUSION

This study we concluded importance of essential oil used in the food industry. The piper species essential oils have the main chemical components like the monoterpene hydrocarbon (-limonene, sabinene, -thujene), sequiterpene hydrocarbon (-caryophyllene), oxygenated monoterpene (-linalool), oxygenated sequiterpene (caryophyllene oxide) and the phenylpraponoid (eugenol). The main chemical compound on the piper species oil has the MIC score of 1.5 to 2.8 μg/mL towards the bacteria stain for the preservative standard. The MIC score is very good, which is by showing the lowest concentration in inhibiting bacteria on the food preservation standard. That makes the essential oil of the piper species has the function in inhibiting the food pathogen. The antioxidants activity on the essential oil of the piper species can inhibit the oxidation process more than 50%. This shows that the essential oil of piper species is good in preventing the lipid oxidation on foods. The comparison result of the oil and the BHA BHT as the synthetic antioxidants shows that the antioxidants on the essential oil of piper species are stronger in terms of preventing oxidation. The literature shows that the essential oil of the piper species has the safe certification from GRAS and the US FDA and it also has the promising future prospect as a food preservative.

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